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LOWER GRANITE RESERVOIR, GARFIELD AND WHITMAN COUNTIES, WASHINGTON

NATIONAL EUTROPHICATION SURVEY
LAS VEGAS, NEVADA

PREPARED FOR
ENVIRONMENTAL MONITORING AND SUPPORT LAB.
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REPORT

ON

LOWER GRANITE RESERVOIR

GARFIELD AND WHITMAN COUNTIES

WASHINGTON

EPA REGION X

WORKING PAPER NO. 876

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16 ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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GARFIELD AND WHITMAN COUNTIES, WASHINGTON

EPA REGION X

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

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Corvallis Environmental Research Laboratory
Corvallis, Oregon

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Washington Department of Ecology for professional involvement, to the Washington National Guard for conducting the tributary sampling phase of the Survey, and to those Washington wastewater treatment plant operators who provided effluent samples and flow data.

Ms. Barbara Blau, Lake Restoration Program, and the staff of the Washington Department of Ecology, Lake Restoration Program, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

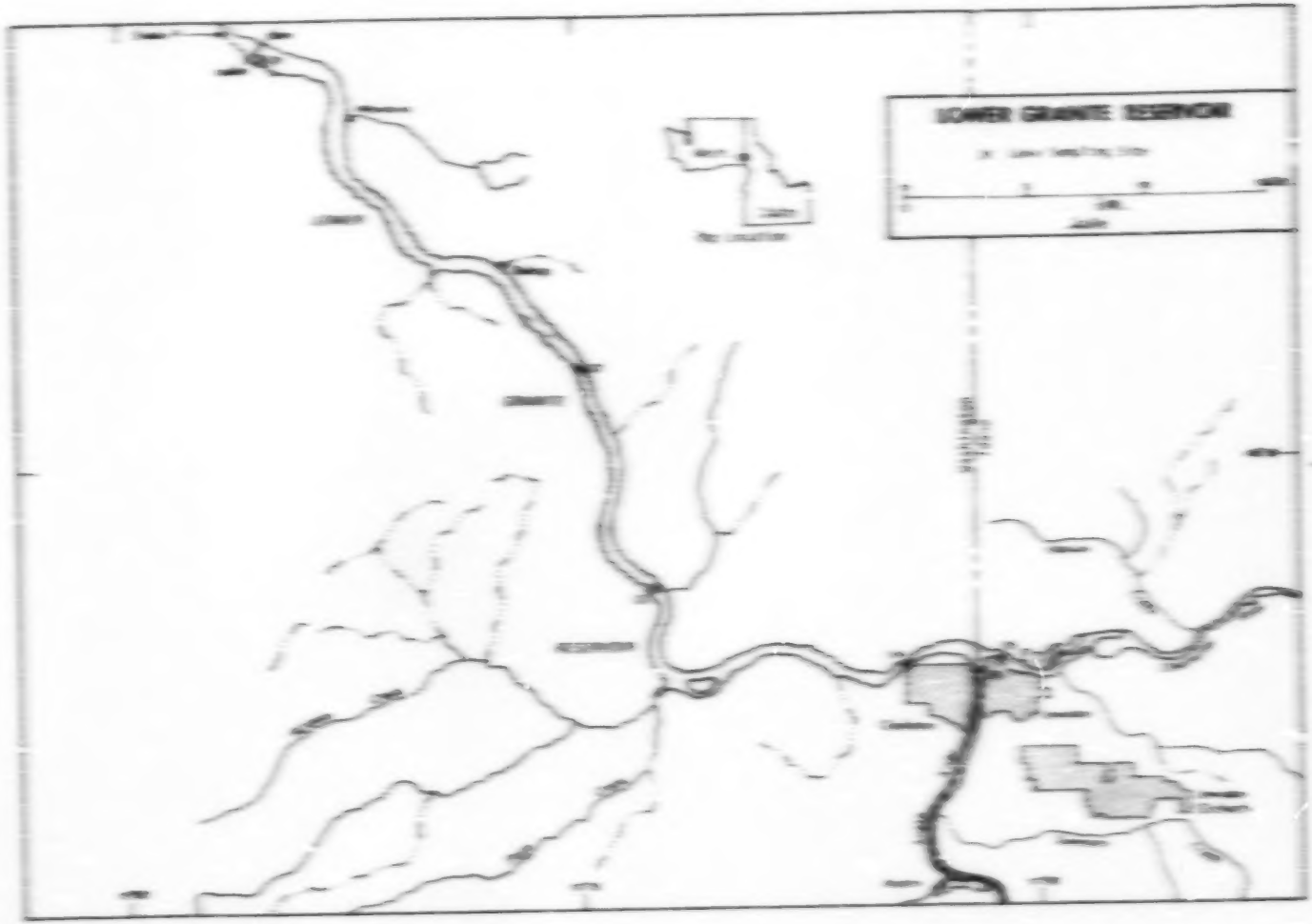
Major General Howard S. McGee, Adjutant General of Washington, and Project Officer Colonel Clinton C. Johnson, who directed the volunteer efforts of the Washington National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WASHINGTON

LAKE NAME	COUNTY
American Lake	Pierce
Banks Lake	Grant, Douglas
Chelan Lake	Chelan
Diamond Lake	Pend Oreille
Green Lake	King
Keechelus Lake	Kittitas
Mayfield Lake	Lewis
Medical Lake	Spokane
Moses Lake	Grant
Ozette Lake	Clallam
Sammamish Lake	King
Lake Whatcom	Whatcom
Lower Granite Reservoir	Garfield, Whatcom



REPORT ON LOWER GRANITE RESERVOIR, WASHINGTON

STORET NO. 5313

I. INTRODUCTION

Lower Granite Reservoir was included in the National Eutrophication Survey (NES) as a water body of special interest to the Washington Department of Ecology. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

II. CONCLUSIONS

A. Trophic Condition:*

Based upon Survey data Lower Granite Reservoir is considered eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Potential for primary productivity as measured by algal assay control yield was high in the lake on both sampling occasions. Secchi disc visibility was only about 1.5 m (60 inches) throughout the lake except at Station 06 where it was substantially higher. Of the 13 Washington lakes sampled in 1975, 7 had higher median total phosphorus levels (0.033 mg/l) 1 had higher median inorganic nitrogen values (0.150 mg/l) and

*See Appendix C.

2 had higher median orthophosphorus levels (0.022 mg/l) than Lower Granite Reservoir.

Survey limnologists did not observe any problem conditions during their visits to the lake.

B. Rate-Limiting Nutrient:

Algal assay results indicate nitrogen limitation in Lower Granite Reservoir during July sampling and phosphorus limitation in September. The lake data suggest primary limitation by nitrogen on both sampling rounds.

III. LAKE CHARACTERISTICS

A. Lake Morphometry:*

1. Surface area: 36.42 km^2.
2. Mean depth: 13.7 meters.
3. Maximum depth: 41.1 meters.
4. Volume: 498.954 x 10^3 m^3.

B. Precipitation:

1. Year of sampling: 67.8 cm.
2. Mean annual: 53.1 cm.

*Lake surface area and maximum depth were provided by the Washington Department of Ecology (1973). Mean depth and volume were estimated on the basis of National Eutrophication Survey (NES) data.

IV. LAKE WATER QUALITY SUMMARY

Lower Granite Reservoir was sampled two times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from six stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During both visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 36.9 meters at Station 01, 28.4 meters at Station 02, 26.5 meters at Station 03, 10.7 meters at Station 04, 9.8 meters at Station 05, and 7.9 meters at Station 06. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix B and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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		[illegible]					[illegible]			
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
07/23/75	1. Skeletonema	630
	2. Centric Diatoms	540
	3. Fragilaria	210
	4. Chroomonas	60
	5. Nitzschia	60
	Other genera	150
	Total	1,650
09/12/75	1. Melosira	810
	2. Chroomonas	778
	3. Skeletonema	195
	4. Cyclotella	162
	5. Nitzschia	130
	Other genera	812
	Total	2,887

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
07/23/75	01	9.6
	02	4.5
	03	4.2
	04	2.5
	05	2.6
	06	6.1
09/12/75	01	5.1
	02	3.2
	03	4.5
	04	4.9
	05	5.3
	06	7.5

c. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. 07/23/75 Stations 01-04

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.008	0.080	3.9
0.05 P	0.058	0.080	4.1
0.05 P + 1.0 N	0.058	1.080	12.2
1.00 N	0.008	1.080	16.0

Stations 05, 06

Control	0.015	0.055	3.5
0.05 P	0.065	0.055	3.9
0.05 P + 1.0 N	0.065	1.055	27.6
1.00 N	0.015	1.055	6.6

b. 09/12/75 Stations 01-03

Control	0.020	0.230	1.1
0.05 P	0.070	0.230	9.7
0.05 P + 1.0 N	0.070	1.230	20.5
1.00 N	0.020	1.230	1.1

Stations 04-06

Control	0.020	0.240	1.6
0.05 P	0.070	0.240	9.4
0.05 P + 1.0 N	0.070	1.240	13.0
1.00 N	0.020	1.240	2.1

F. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary production in Lower Granite Reservoir was high on both sampling occasions (07/23/75, 09/12/75). During July sampling, the addition of nitrogen spikes produced a substantial increase in yield over that of the control, indicating nitrogen limitation. During September sampling, a significant increase in yield accompanied the addition of orthophosphorus, indicating phosphorus limitation at that time. In all assays the maximum growth response over that of the control was achieved with the simultaneous addition of both nutrients.

The mean inorganic nitrogen to orthophosphorus ratio (N/P) in the lake data were approximately 6/1 and 10/1 in July and October, respectively, suggesting nitrogen limitation in Lower Granite Reservoir on both lake sampling occasions.

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Washington Department of Ecology. 1973. Lakes of Washington, Volume II. Washington State Water Program, Olympia, Washington.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

PHYSICAL AND CHEMICAL DATA

[illegible]

$$\frac{\partial}{\partial x}\left(\frac{\partial}{\partial x}\right) = \frac{\partial^2}{\partial x^2}$$

$$\frac{\partial}{\partial x}\left(\frac{\partial}{\partial y}\right) = \frac{\partial^2}{\partial x \partial y}$$

$$\frac{\partial}{\partial y}\left(\frac{\partial}{\partial x}\right) = \frac{\partial^2}{\partial y \partial x}$$

$$\frac{\partial}{\partial y}\left(\frac{\partial}{\partial y}\right) = \frac{\partial^2}{\partial y^2}$$

[illegible]

[illegible]

APPENDIX C

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF WASHINGTON

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Washington lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in ug/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

LAKE DATA TO BE USED IN RANKING

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	[illegible] SEC	[illegible] CHLPHA	[illegible] MIN SD	[illegible] SIGS DPTH P
5301	[illegible] LAKE	0.027	0.195	343.000	4.622	15.000	0.007
5302	[illegible] LAKE	0.421	0.040	304.533	7.373	10.000	0.007
5303	[illegible] LAKE	0.105	0.073	111.000	0.405	6.400	0.007
5304	[illegible] LAKE	0.014	0.047	303.167	14.537	14.200	0.010
5305	[illegible] LAKE	0.427	0.250	425.500	2.003	10.407	0.000
5306	[illegible] LAKE	0.007	0.040	200.250	1.401	0.270	0.007
5307	[illegible] LAKE	0.014	0.107	402.030	4.250	10.400	0.007
5308	[illegible] LAKE	0.275	0.225	401.734	20.425	15.200	0.144
5309	[illegible] LAKE	0.115	0.150	403.400	25.200	14.470	0.030
5310	[illegible] LAKE	0.010	0.110	403.333	1.225	7.200	0.000
5311	[illegible] LAKE	0.015	0.210	374.000	7.200	14.407	0.004
5312	[illegible] LAKE	0.100	0.320	200.000	3.427	10.400	0.000
5313	[illegible]	0.033	0.150	435.500	4.075	7.200	0.027

PERCENT OF LAKES WITH VIEWED VALUES (NUMBER OF LAKES WITH VIEWED VALUES)

LAKE CODE	LAKE NAME	WATER TOTAL P	WATER INORG N	SUB-WATER SEC	WATER CHLORA	15-WATER TEMP	WATER DISS OXYGEN P
5301	AMERICAN LAKE	29 (31)	52 (61)	67 (81)	50 (61)	4 (51)	58 (71)
5302	BANKS LAKE	47 (51)	100 (121)	58 (71)	25 (31)	44 (51)	71 (41)
5303	CHELAN LAKE	100 (121)	67 (81)	100 (121)	100 (121)	100 (121)	42 (111)
5304	DIAMOND LAKE	67 (71)	75 (91)	75 (91)	17 (21)	32 (41)	25 (31)
5305	GRAPH LAKE	29 (31)	83 (101)	17 (21)	75 (91)	67 (71)	44 (91)
5306	HEDDEMAN LAKE	97 (111)	92 (111)	92 (111)	83 (101)	75 (91)	100 (121)
5307	HOFFELT LAKE	67 (71)	58 (71)	33 (41)	58 (71)	42 (71)	71 (81)
5308	MEDICAL LAKE	0 (81)	8 (11)	67 (81)	0 (11)	4 (81)	0 (81)
5309	MOSES LAKE	0 (17)	25 (31)	0 (81)	0 (01)	21 (21)	0 (11)
5310	BEETTE LAKE	75 (81)	42 (51)	25 (31)	92 (111)	87 (101)	33 (41)
5311	SAMMAMISH LAKE	57 (41)	17 (21)	58 (41)	33 (41)	21 (21)	43 (171)
5312	WATSON LAKE	43 (101)	0 (81)	43 (101)	67 (81)	44 (91)	44 (91)
5313	LOWER SPOKANE RESERVOIR	17 (21)	25 (31)	0 (11)	42 (51)	67 (101)	17 (21)